

Rejection Basin Detection Using the Integral Spectral Analysis (ISA) Method, Niquelândia, Brazil

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Introduction

Niquelândia lateritic nickel deposits lie in the central portion of Brazil's Goiás State-, about 23 km north of Niquelândia city. The Niquelândia Complex is a well-exposed, large, layered intrusion in central Brazil that comprises an area of about 1,800 square km and is approximately 15 km thick. Geology (Ferreira Filho *et al.*, 1992) and petrology (Girardi *et al.* 1986) studies showed many similarities between the Niquelândia Complex and well-known Precambrian layered intrusions such as Bushveld and Stillwater. Nevertheless, these layered intrusions (the Niquelândia Complex) show widespread tectonism and associated amphibolite to granulite facies metamorphism (Ferreira Filho *et al.*, 1992 and Ferreira Filho & Fawcett, 1992). Deposits are located in the ultrabasic zone of the Niquelândia Basic-Ultrabasic Complex as a result of the residual concentration developed by rocks weathering in this zone. There are two types of ore: garnierite and oxidated ore (Pedroso & Schmatz, 1986).

In 1973 the Níquel Tocantins Company built a metallurgic complex to produce nickel carbonate from lateritic ore. Nickel carbonate is transported to São Paulo, where metallic nickel is produced. The wastes are stockpiled in sedimentation basins around the company. Mainly opaque minerals (maghemite and magnetite) constitute the wastes.

The AVIRIS image shows the mill, rejection basins and the dam (Figure 1). The present work uses AVIRIS images in order to characterize the rejection basins formed by opaque minerals (Photo 1).

Methodology

Due to the lack of a specific absorption features in the ore rejection, spectral classification methods such as Tricorder (Clark *et al.*, 1990 and Clark & Swayze, 1995) and Spectral Feature Fitting (ENVI, 1997) are not effective. Diagnostic characteristics of the rejection minerals are the low reflectance throughout the spectral range.

A new procedure was proposed by Ribeiro *et al.* (2000) in order to detect opaque minerals. The method is based on two steps:

- a) Discrimination of low albedo areas through the ISA algorithm, and
- b) Segmentation of the low albedo materials by using MNF and scatterplot analysis.

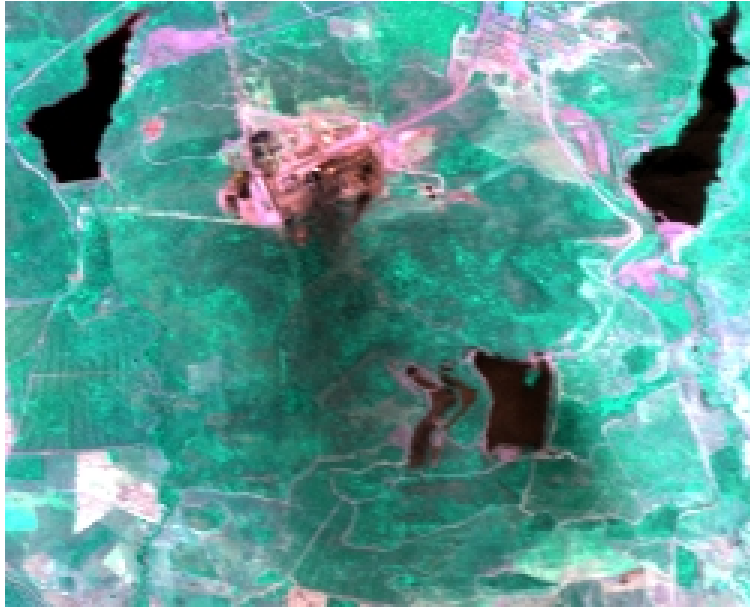


Figure 1 – AVIRIS image of the Niquelândia mill (bands 30/60/90)



Photo 1 – Rejection basin

The ISA accomplishes a sum of reflectance intensity on bands multiplied by their respective FWHM:

$$\text{Spectral Integral} = \sum (R_b * \text{FWHM}_b)$$

Low-reflectance areas were separated, in order to make a mask, and applied in the MNF transformation. The MNF procedure is derived from the PCA (Principal Component Analysis). The main difference between them is that MNF considers the noise and PCA the data variation. MNF transformation is considered a method to order hyperspectral data in terms of image quality (Green *et al.*, 1988.).

Results and Conclusion

The rejection is mainly formed by the opaque maghemite and magnetite minerals characterized by low albedo. From ISA a mask was made isolating the water in the rejection basins. MNF was applied in the image using the mask (Figure 2).

A color composite of MNF images enhanced the two targets (Figure 3). In the rejection basin a variation of behavior can be observed due to opaque concentration. The use of the MNF scatterplot allows separating the rejection basins in the areas with major (black) and minor (red) opaque concentration (Figure 4). The dam is represented by the blue area where the dark blue corresponds to the edge with the highest data dispersion.

The methodology presented here is an efficient method for mapping an opaque body.



Figure 2 – Mask image built from ISA Method



Figure 3 - MNF image to the study area.

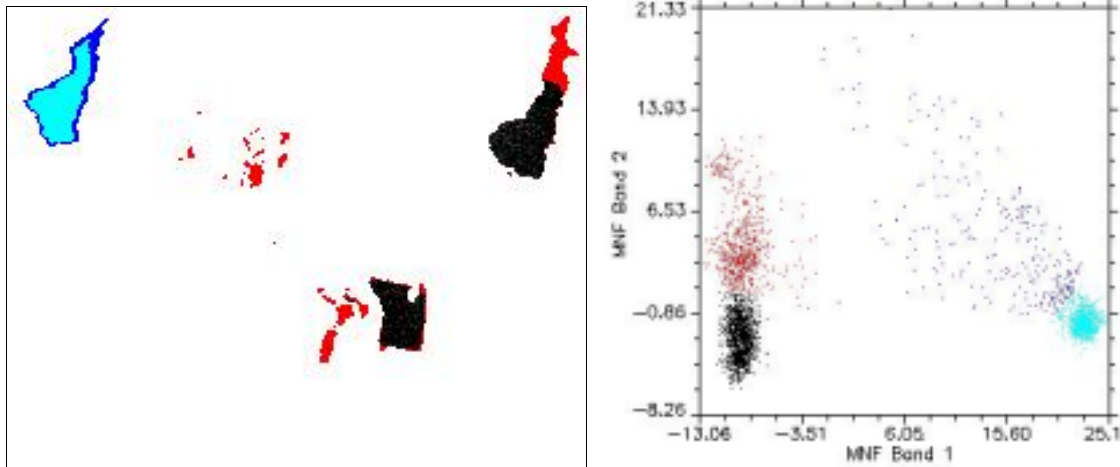


Figure 4 – Different behavior of rejection areas (black and red) in relation to the dam (blue)

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